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PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant	:	Martin T. Pearson
Application No.	:	10/017,470
Filed	:	December 14, 2001
For	:	METHOD AND APPARATUS FOR CONTROLLING VOLTAGE FROM A FUEL CELL SYSTEM

Examiner	:	Gregg Cantelmo
Art Unit	:	1745
Docket No.	:	130109.436

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

DECLARATION OF MARTIN T. PEARSON
PURSUANT TO 37 CFR 1.132

I, Martin T. Pearson, declare as follows:

1. I am a Principal Applied Scientist at Ballard Power Systems Inc., the assignee of the above-identified patent application, and I am also the sole inventor named in the application. In addition, my educational and professional background includes, five years of university, twenty-three years of Engineering experience in corporate research and development with five of those years working specifically on PEM fuel cell systems.

2. I am familiar with the content of the application, and I have reviewed the Office Action mailed October 21, 2003, including the objections and rejections contained therein. It is my conclusion that a person of ordinary skill in the art would understand how the pressure of at least one reactant flow can be held approximately constant while adjusting the partial pressure of the reactant flow. My explanation is provided in the subsequent paragraphs.

3. The Examiner states that the specification of the present application is not clear as to how the pressure of at least one reactant flow can be held

approximately constant while adjusting the partial pressure of the reactant flow. See, *e.g.*, paragraphs 5 and 8 of the Office Action.

4. A person skilled in the art would understand that the stream of gas flowing through the anode or cathode of a fuel cell might contain gasses other than the reactants. For example, in PEM fuel cells, the cathode gas stream is typically air. Air contains the oxidant (oxygen) that is consumed by the reaction, as well as nitrogen, carbon dioxide and other gases. Similarly, if the anode of a fuel cell is being fed reformate, the anode inlet stream will contain the reaction fuel (hydrogen), as well as carbon dioxide, carbon monoxide and other gases. The total pressure of the stream is the sum of the partial pressures of the various gasses contained in that stream.

5. A person of ordinary skill in the art would understand how a reactant partial pressure could be varied without varying the total working pressure of the anode or cathode gas streams. It is known in the fuel cell art that the total gas pressure can be regulated independent of gas stream composition. Indeed, it has been recognized in the PEM fuel cell art that it is convenient to maintain relatively constant reactant pressures, as significant pressure differentials across the electrolyte membrane may reduce operating lifetime and, if large enough, can damage the membrane. For example, if a portion of the cathode exhaust gas (nitrogen rich - oxygen depleted) stream is recycled to the cathode inlet stream, it is possible to lower the partial pressure of oxygen (oxidant) in the inlet stream while holding the total pressure of the stream constant (higher nitrogen partial pressure makes up the difference).

6. Similarly, a person skilled in the art would understand that if reformate is supplied to the anode of a fuel cell, the anode exhaust stream will contain a higher percentage of carbon dioxide than the anode inlet stream, as the fuel cell consumes hydrogen and not carbon dioxide. If some of the anode exhaust gas is recycled back to the anode inlet stream, the partial pressure of hydrogen can be lowered while the anode inlet stream pressure can be held constant.

7. Another example applies in PEM fuel cells where the fuel supply to a fuel cell stack is closed (i.e., the anode supply system is dead-ended or includes a recycle loop). A person skilled in the art would understand that if the stack is supplied

with hydrogen and air, nitrogen in the air permeates the electrolyte membrane and accumulates on the anode side of the fuel cells. The partial pressure of hydrogen can be adjusted by depletion or the introduction of additional hydrogen, without changing the total gas pressure.

8. As a further example, the hydrogen content (partial pressure) of a reformate stream, and/or the oxygen content (partial pressure) of an air stream, can be enhanced by a pressure swing absorption (PSA) system. A person skilled in the art will understand that reducing the effectiveness of the PSA process will decrease the partial pressure of hydrogen or oxygen in the respective reactant stream but the stream pressure can be maintained constant.

9. Yet another example, described in Boyer et al., employs an oxygen permeable membrane for oxygen enrichment of an air stream supplied to fuel cells. At low fuel cell currents, low gas flow rates minimally increase the oxygen concentration in the air. At high fuel cell currents, high gas flow rates increase the oxygen concentration fed to the cathode air. However, the operating pressure of the fuel cell is not changed. See, *e.g.*, Boyer et al., "Evaluation of Methods to Increase the Oxygen Partial Pressure in PEM Fuel Cells," *Journal of Applied Electrochemistry*, Vol. 29, pages 1095-1102, 1999, at page 1101. A copy of Boyer et al. is provided for the Examiner's review in the Supplemental Information Disclosure Statement submitted herewith.

I hereby declare that all statements made herein are, to my own knowledge, true and that all statements made on information or belief are believed to be true; and further that these statements are made with the knowledge that willful false statements and the like are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the captioned patent application or any patent issued therefrom.

MARCH 8TH 2004
Date

M T Pearson
Martin T. Pearson

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